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15.3
Crane, Hoist, and Rigging Safety

(Formerly H&SM S29.01)

Recommended for approval by the ES&H Working Group

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New document or new requirements

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☐ **New document**
☒ **Major requirement change**
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15.3

Crane, Hoist, and Rigging Safety *

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* Major revision

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15.3

Crane, Hoist, and Rigging Safety

1.0 Introduction

Cranes, hoists, and rigging equipment need to be designed, used, and maintained properly to avoid accidents and injuries. This document contains specific safety requirements to prevent adverse consequences. These requirements apply to all LLNL operations involving the use of cranes, hoists, and associated rigging.

The lifting equipment covered by this document includes, but is not limited to, the following:

- Overhead and gantry cranes.
- Mobile cranes.
- Cab- and pulpit-operated cranes.
- Powered and manual hoists (including manual lever-operated hoists).

LLNL has adopted Department of Energy (DOE) Standard 1090-99 (DOE-STD-1090-99), "Hoisting and Rigging," into the Work Smart Standards set. DOE-STD-1090-99 is a thorough DOE-wide consensus standard for crane and hoist operations and the use of rigging equipment, and has been prepared and adopted for use throughout the DOE complex. DOE-STD-1090-99 includes, as content and reference material, all applicable industry standards and regulations governing this type of work.

Previous editions of this document contained both LLNL-specific safety requirements and selected requirements from other regulations and standards. However, because of the large volume of information available and the complexity of the related requirements, this document now acts primarily as a pointer to DOE-STD-1090-99.

In addition, this document lists LLNL-specific work practices and requirements that are not included in DOE-STD-1090-99 and contains links to sections of DOE-STD-1090-99 that apply to common operations and uses of cranes, hoists, and associated rigging and that are necessary to safeguard employees and equipment. Contact your Environment, Safety, and Health (ES&H) Team for issues not addressed in this document or for any other questions about cranes, hoists, and rigging safety.

Organizations conducting work covered by this document shall meet all requirements stated herein no later than August 16, 2002.

2.0 Hazards

Improper use of cranes, hoists, and rigging devices can cause equipment to fail or loads to drop from the lifting system, resulting in personnel injury, death, significant property loss, or damage to the environment.

3.0 Controls

Many types of cranes, hoists, and rigging devices are used at LLNL for lifting materials and equipment. LLNL's goal is to maintain safety during operation of such equipment. Therefore, all LLNL employees, supplemental-labor workers, and subcontractor personnel who use such devices shall adhere to the requirements in this section and to the safety standards in Section 6.0.

3.1 Qualifications for Crane and Hoist Operators

All workers who use any Laboratory crane or hoist shall have an operator's license or be otherwise qualified according to industry standards, as follows:

- The Hazards Control Department issues two types of licenses: one for small, incidental operations; and the other for larger, intermediate operations. The licenses are valid for a period not to exceed 3 years from date of issue, unless revoked sooner by management.
- The Plant Engineering Department assures the qualification and certification, by outside providers, of professional riggers in accordance with recognized industry standards. Professional riggers are qualified operators who are able to rig and lift loads up to the capacity of the equipment used.

Subcontractor personnel (excluding supplemental-labor and labor-only workers) who operate LLNL cranes shall meet Occupational Safety and Health Administration (OSHA) regulations for operator training and qualification for the equipment they operate. Such operators shall be briefed on the operation and limitations of the particular cranes or hoists and shall demonstrate the ability to operate the equipment safely and in accordance with the requirements of DOE-STD-1090-99 and the crane or hoist manufacturer. The Responsible Individual shall ensure that a record of the briefing is documented and forwarded to the contract administrator for inclusion in official contract records.

If input provided by the work supervisor and ES&H Team indicates that a crane operator is required to have periodic medical examinations because of unusual physical requirements or high-hazard consequences for a particular lifting operation, the Health

Services Department conducts the examination. For more information about medical certification, refer to Document 10.1, "Occupational Medical Program," in the *ES&H Manual.*

3.1.1 Incidental Crane and Hoist Operators

Incidental crane and hoist operators are licensed to make lifts up to 900 kg (2000 lb) if conventional rigging equipment is to be used or up to 225 kg (500 lb) when the use of special (i.e., nonconventional) rigging equipment may be required. (See Appendix A for the definitions of conventional rigging, special rigging, and other terms used in this document.) When an incidental crane and hoist operator routinely lifts loads between 225 kg and 900 kg, the Responsible Individual should contact the area ES&H Team for an evaluation of the lift operation. When loads exceed 900 kg, the Responsible Individual shall have an intermediate crane operator or Plant Engineering riggers make the lift.

To be qualified as an incidental crane and hoist operator, the candidate shall:

- Complete course HS5690, "Incidental Crane Safety."
- Receive hands-on training from a licensed, qualified crane and hoist operator designated by the candidate's supervisor.

Upon successful completion of training, the licensed crane and hoist operator and the candidate's supervisor fill out and sign the Qualification Request Form and Safety Checklist (see Appendix B) and send the forms to the Safety, Education, and Training Section of the Hazards Control Department for approval. The candidate is issued a license upon Hazards Control Department approval.

Incidental crane and hoist operators shall renew their license every 3 years by satisfying the requirements described above. Renewing an intermediate crane operator's license (or obtaining a new intermediate crane operator's license) satisfies the renewal requirements for an incidental crane and hoist operator's license.

3.1.2 Intermediate Crane Operators

Intermediate crane operators are licensed to make lifts up to 4500 kg (10,000 lb) using building cranes or hoists and special rigging equipment. To be qualified as an intermediate crane operator, the candidate shall:

- Fulfill all the requirements described in Section 3.1.1.
- Complete Course HS5700, "Intermediate Crane Safety," which includes required hands-on training.

Relicensing for intermediate crane operators is required every 3 years and also satisfies the requirements for incidental crane and hoist operators.

3.1.3 Operators of Mobile or Cab- or Pulpit-Operated Cranes and Riggers

Mobile crane operators are specially trained and licensed Plant Engineering personnel who are responsible for all LLNL mobile crane rigging and operations. Operators of mobile or cab- or pulpit-operated cranes shall complete a medical certification examination at least every 3 years or more frequently as determined by the Health Services Department. Refer to Document 10.1 for more information.

A rigger is a worker employed by Plant Engineering who is trained, qualified, and designated to make all lifts with cranes and hoists (up to the maximum capacity of the equipment) exceeding the limits for which a licensed incidental crane and hoist operator or an intermediate crane operator is authorized.

3.2 Crane and Hoist Safety Design Requirements

This document does not attempt to list all of the safety design requirements associated with various types of cranes, hoists, rigging hardware, or related components. Specific safety design requirements are listed in the appropriate standards governing the design and manufacture of specific equipment. The requirements are listed in Chapter 16 of DOE-STD-1090-99, with additional guidance provided in Section 7.3 of this document.

If operations fall outside of the requirements of this document or require a deviation from DOE-STD-1090-99, the requirements contained in Document 2.3, "LLNL Exemption Process," in the *ES&H Manual* shall be followed.

3.3 Crane and Hoist Operations

LLNL-required training covers general information for routine crane and hoist operations. Operators should refer to DOE-STD-1090-99 for additional information regarding the use and operation of specific lifting equipment that is covered by the training. Operators of lifting equipment shall comply with specific operating limitations and requirements stated in the manufacturer's instructions.

The following chapters of DOE-STD-1090-99 contain detailed information about each topic, including inspection, testing, maintenance, and operational requirements:

Chapter 4, "Lifting Personnel."

Chapter 7, "Overhead and Gantry Cranes."

Chapter 8, "Hoists."

Chapter 9, "Mobile Cranes."

Chapter 11, "Wire Rope and Slings."

Chapter 12, "Rigging Accessories."

Chapter 13, "Load Hooks."

Chapter 14, "Below the Hook Lifting Devices."

Chapter 15, "Construction Hoisting and Rigging Equipment Requirements."

In addition, operators shall comply with the following rules while operating cranes and hoists:

- Before beginning work, plan the operation using an Integration Work Sheet (IWS), as appropriate.
- At the start of each work shift, conduct a daily preoperational check prior to operating lifting equipment.
- Do not engage in any practice that could divert your attention while operating the crane.
- Respond to signals only from the person who is directing the lift or any appointed signal person. Obey a stop signal at all times, no matter who gives the signal. Appendix C contains standard hand signals.
- Do not move a load over people. (People shall not be placed in jeopardy by being under a suspended load.)
- Do not work under a suspended load unless
  - — The load is supported by blocks, jacks, or a solid footing that safely supports the entire weight.
  - — The crane or hoist operator remains at the controls or lock open and tag the main electrical disconnect switch.
- Ensure that the rated load capacity of a crane's bridge, individual hoist, or any sling or fitting is not exceeded. Know the weight of the object being lifted or use a dynamometer or load cell to determine the weight.
- Check that all controls are in the OFF position before closing the main electrical disconnect switch.
- To prevent shock loading, avoid sudden stops or starts. (Shock loading, which can occur when a suspended load is accelerated or decelerated, can overload the crane or hoist.) When completing an upward or downward motion, ease the load slowly to a stop.

3.4 Parking a Crane or Hoist

Facilities differ in the type and configuration of cranes and hoists used in their work spaces. The Responsible Individual shall ensure that the crane or hoist, as well as any associated components or rigging, does not become a hindrance to emergency egress or personal safety.

At a minimum, the following items shall be accomplished whenever possible when parking an overhead crane or hoist:

- Remove all slings and accessories from the hook. Return the rigging device to the designated storage racks.
- Raise the hook at least 2.1 m (7 ft) above the floor.
- Store the pendant away from aisles and work areas, or raise it at least 2.1 m (7 ft) above the floor.
- Place the emergency stop switch (or pushbutton) in the OFF position.
- Park and secure a mobile crane in accordance with the manufacturer's recommendations.
- Whenever possible, park an overhead crane or hoist at the access ladder to the service platform.

3.5 Rigging

The term "rigging" refers to both of the following:

- The hardware and equipment used to safely attach a load to a lifting device.
- The art or process of safely attaching a load to a hook by means of adequately rated and properly applied slings and related hardware.

3.5.1 General Rigging Safety Requirements

The following requirements apply:

- Only rigging equipment that is in good condition and is not suspect or counterfeit may be used. Document 41.3, "Suspect / Counterfeit Items," in the *ES&H Manual* describes the process used to identify and control suspect and counterfeit items.
- All rigging equipment shall be visually inspected by the operator prior to use. In addition, shackles, turnbuckles, eyebolts, links, rings, metal clamps, and other similar rigging hardware shall be checked periodically for safety. Written records of such checks are not required.

- All rigging equipment shall be protected from physical damage caused by neglect, abuse, or misuse.
- All rigging equipment shall be stored and maintained in accordance with the manufacturer's recommendations.
- Slings (e.g., wire rope, synthetic web or rope, metal mesh, and chain) and rigging hooks shall
    - Be inspected at least annually by a qualified inspector.
    - Have a documented inspection history, with records readily available.
    - Be labeled for identification purposes with a durable tag (synthetic or metal) permanently affixed to the device. Equipment that is not properly labeled shall not be used. However, manufacturer-supplied serial numbers or other individualized markings that identify the equipment meet the labeling requirement.

The Responsible Individual for the equipment shall ensure that a designated person, as defined by DOE-STD-1090-99, determines whether conditions found during inspection constitutes a hazard and whether a more detailed inspection is required. Defective equipment shall be removed from service and destroyed to prevent inadvertent reuse.

All rigging equipment shall be maintained, inspected, tested (or calibrated), inventoried, and stored in accordance with the requirements of DOE-STD-1090-99. The Responsible Individual shall ensure that equipment purchased through commercial channels meets or exceeds the requirements. Special rigging equipment (e.g., hardware and lifting devices) that is manufactured onsite is addressed in Section 3.5.3, "Special Rigging Equipment."

Examples of conditions that may require rigging hardware to be removed from service include the following:

- Synthetic slings with
    - Abnormal wear.
    - Torn stitching.
    - Visible red threads from the interior of the sling fabric.
    - Broken or cut fibers.
    - Discoloration or deterioration.
    - Evidence of heat damage.
- Wire-rope slings with
    - Kinking, crushing, bird-caging, or other distortions.
    - Evidence of heat damage.
    - Cracks, deformation, or worn end attachments.
    - Broken wires in excess of regulatory requirements.

  - Hooks opened more than 15% at the throat.
  - Hooks twisted sideways more than 10° from the plane of the unbent hook.

- Alloy steel chain slings with
  - Cracked, bent, or elongated links or components.
  - Cracked hooks.

- Shackles, eye bolts, turnbuckles, or other components that are damaged or deformed.

More detailed requirements on the inspection, maintenance, and testing requirements for rigging hardware is contained in the chapters of DOE-STD-1090-99 applicable to the components in question. The manufacturer's requirements shall also be consulted, and the most conservative requirements shall prevail.

3.5.2 Rigging a Load with Rigging Equipment

Do the following when rigging a load:

- Determine the weight of the load. Do not guess.
- Determine the proper size for slings and components. Refer to DOE-STD-1090-99 for details.
- Do not use manila rope for rigging.
- Make sure that shackle pins and shouldered eye bolts are installed in accordance with the manufacturer's recommendations.
- Make sure that ordinary (i.e., shoulderless) eye bolts are threaded in at least 1.5 times the bolt diameter.
- Use safety hoist rings (i.e., swivel eyes) as a preferred substitute for eye bolts whenever possible.
- Pad sharp edges to protect slings. Machinery foundations or angle-iron edges may not feel sharp to the touch but could cut into rigging when under several tons of load. Wood, tire rubber, or other pliable materials may be suitable for padding.
- Do not use slings, eye bolts, shackles, or hooks that have been cut, welded, or brazed.
- Determine the center of gravity, and balance the load before moving it. Keep the attachment points of rigging accessories as far above and as far away from the center of gravity as possible.

- Initially lift the load only a few inches to test the rigging and balance.
- Protect rigging hardware as required. Items left in the sun may have surface temperatures that exceed the safe limits of synthetic lifting devices.

3.5.3 Special Rigging Equipment

Rigging equipment and lifting fixtures may be designed and manufactured at LLNL for specific purposes. Such special rigging equipment shall be certified with an MESN or other, equivalent test documentation indicating the equipment's use and design criteria. Conventional rigging equipment purchased from a vendor is not normally considered special rigging equipment. Contact the Mechanical Engineering or Hazards Control Department if you have questions concerning such equipment.

3.6 Crane Overloading

Cranes or hoists shall not be loaded beyond their rated capacity. Any crane or hoist suspected of having been overloaded shall be removed from service by locking open and tagging the main electrical disconnect switch. In addition, overloaded cranes shall be inspected, repaired, load tested, and approved for use by qualified personnel before being returned to service.

Information on load testing and extraordinary loading conditions of cranes and hoists can be found in DOE-STD-1090-99.

3.7 Working at Heights on Cranes or Hoists

Fall protection:

- Shall be used by all personnel conducting maintenance or repair on cranes or hoists at heights greater than 1.8 m (6 ft).
- Should also be considered for heights less than 1.8 m.
- Includes properly secured safety nets and safety harnesses that are fitted with a lifeline and securely attached to a structural member of the crane or building.

Additional information regarding working at elevated work surfaces can be found in Documents 15.1, "Roof Access," and 11.1, "Personal Protective Equipment," in the *ES&H Manual.*

Use of an overhead crane as a work platform should only be considered when all other conventional means of reaching an elevated worksite are hazardous or not possible (refer to Section 3.10 for additional information). Workers shall not ride a moving bridge crane without an approved OSP, which shall include the following requirements as a minimum:

- Personnel shall not board any bridge crane unless the main electrical disconnect switch is locked and tagged open.
- Personnel shall not use bridge cranes without a permanent platform (i.e., catwalk) as a work platform. Bridge catwalks shall have a permanent ladder access.
- Personnel shall ride seated on the floor of a permanent platform with approved safety handrails, wear safety harnesses attached to designated anchors, and be in clear view of the crane operator at all times.
- Operators shall lock and tag open the main electrical (or power) disconnect switch on the bridge catwalk when the crane is parked.

When performing functional tests that require electrical power, crane and hoist maintenance personnel shall follow the safe work procedures in Document 16.2, "Work and Design Controls for Electrical Equipment," in the *ES&H Manual*. Work shall also be performed in accordance with an approved safety plan.

3.8 Hand Signals

The hand signals shown in Appendix C shall be used to communicate with operators unless voice communications equipment (i.e., telephone, radio, or equivalent) is used. Signals shall be discernible or audible at all times. Some special operations may require addition to, or modification of, the basic signals shown in Appendix C. For all such cases, special signals shall be agreed upon and thoroughly understood by both the person giving the signals and the operator, and shall not conflict with the standard signals defined in DOE-STD-1090-99 and in OSHA requirements.

3.9 Critical Lifts

Some lifts may be determined to be a critical lift, which is defined in DOE-STD-1090-99 as one in which collision, upsetting, or dropping could result in one or more of the following:

- Unacceptable risk of personnel injury or significant adverse health impact (either onsite or offsite).

- Significant release of radioactive or other hazardous material or other undesirable conditions.
- Undetectable damage that would jeopardize future operations or the safety of a facility.
- Damage that would result in unacceptable delay to schedule or other significant program impact such as loss of vital data.

A lift shall also be designated as critical if the load requires exceptional care in handling because of size, weight, close-tolerance installation, high susceptibility to damage, or other unusual factors.

The authorizing organization shall identify and designate personnel responsible for making lift category determinations in accordance with Section 2.1 of DOE-STD-1090-99. In addition, the organization shall assign a person in charge of the entire lifting operation, in accordance with Section 2.2b of DOE-STD-1090-99. Refer to Chapter 2, "Critical Lifts," of DOE-STD-1090-99 for complete information regarding critical lifts.

3.10 Lifting Personnel

It is not common Laboratory practice to lift personnel using the load hooks of cranes or hoists. However, if such work is required, refer to Chapter 4, "Lifting Personnel," of DOE-STD-1090-99 for complete information regarding the lifting of personnel.

3.11 Inspection, Maintenance, and Testing

General requirements for inspection, maintenance, and testing are provided to operators in the required training courses. Complete information on inspection and maintenance requirements for specific equipment may be found in the applicable chapters of DOE-STD-1090-99.

In addition, Appendix D contains the schedule for inspection and preventive maintenance of LLNL-operated cranes and hoists.

3.11.1 Monthly Tests and Inspections

All in-service cranes and hoists shall be inspected monthly by a qualified person and the results documented on Form LL-5204 (Monthly Inspection Report for Cranes and Hoists). A Responsible Individual assigned by the facility supervisor shall complete Form LL-5204 for each crane and hoist. The inspector shall forward the white copy of the completed form to the facility manager or facility point of contact (FPOC), forward the yellow copy to the ES&H Team, and retain the pink copy for his or her file.

Cranes and hoists that are completely idle (i.e., fully operational but not required to be used) do not require monthly inspections. Equipment declared as idle shall be locked out of service and tagged with an administrative CAUTION label to alert potential users of inspection requirements that need to be met prior to using the equipment. Cranes or hoists that have been idle for less than 6 months require a monthly inspection prior to being placed back in service. Those that have been idle for more than 6 months shall have a startup annual inspection prior to use. Hoisting equipment that is nonoperational or that requires inspection or repair shall not be designated as idle.

Organizations that elect to designate cranes or hoists as idle may incur additional costs when requesting a startup inspection that does not coincide with the annual inspection schedule. Contact the Plant Engineering Department's Maintenance and Operations Division for additional information prior to placing a crane or hoist in the idle status.

Defective cranes and hoists shall be locked and tagged with an OUT OF SERVICE label until all defects are corrected. The inspector shall initiate corrective action by notifying the facility manager or FPOC.

Standby cranes and hoists (i.e., those that are not in regular service but that are used occasionally or intermittently) shall be inspected at least semiannually and the results documented on Form LL-5204.

3.11.2 Annual Inspections

Both the Maintenance and Operations Division and other responsible organizations shall schedule and supervise (or perform) annual preventive maintenance and annual inspections of cranes and hoists that fall under their area of responsibility. Annual preventative maintenance and inspection shall cover items recommended by the equipment manufacturer or required by DOE-STD-1090-99.

Plant Engineering crane inspectors shall have successfully completed the appropriate training provided by a nationally recognized organization (e.g., North American Crane Bureau) and shall demonstrate professional knowledge to Plant Engineering management. Firms utilized to accomplish inspection requested by Plant Engineering shall be crane surveyors qualified by the State of California.

3.11.3 Load Testing

The load-testing requirements for cranes, hoists, and rigging equipment can be found in the chapters of DOE-STD-1090-99 applicable to the equipment in question.

3.11.4 Records

The Maintenance and Operations Division shall maintain records for any crane or hoist that has been inspected or load tested or that has received a nondestructive evaluation or test. Copies of the records shall be forwarded to the Responsible Individual for the equipment for inclusion into the equipment's records. The Responsible Individual for the equipment shall ensure these records are maintained and properly stored for the lifespan of the equipment.

The Manufacturing and Materials Engineering Division (or an outside vendor contracted by LLNL) shall load-test the following LLNL-designed and -fabricated equipment and affix to the equipment a certifying label with the rated capacity:

- Lifting fixtures covered by an MESN.
- All components (i.e., fixtures without an MESN, scales, and rigging equipment) used for lifting acutely or extremely hazardous materials or for making critical lifts. Appendix A of *Waste Acceptance Criteria* (see Section 7.3) contains a list of hazardous materials.
- Personnel lifting devices (e.g., platforms and baskets).

3.12 Hostile Environments

Hostile environments are areas where radiation, contamination, toxic or hazardous chemicals or gases, or temperature extremes may exist. It may be difficult to perform standard operating procedures, maintenance, inspection, or test procedures on some cranes, hoists, and rigging equipment in such areas. Therefore, a review of the equipment and operations is required to determine the feasibility of compliance with this document and other appropriate standards.

The review shall be conducted by competent individuals appointed by the facility manager, the area ES&H Team, and, as appropriate, the authorizing individual or the Operations and Maintenance Division. An IWS shall be used to document the review. If the review concludes it is not possible or reasonable to follow the requirements in this document because of the environment, a Hostile Environment Plan (see Appendix E) shall be prepared to document alternative methods and controls. In addition, when compliance with required regulations or standards is not feasible, a variance or exemption request shall be prepared and submitted in accordance with Document 2.3.

The responsible individual shall maintain an inventory of all cranes, hoists, and rigging located in hostile environments. Further information on hostile environments can be found in Chapter 5, "Hostile Environments," of DOE-STD-1090-99.

3.13 Additional Requirements for Lifting Explosives

Personnel who use cranes or hoists to handle explosives, but who are not qualified explosives handlers, shall do so only under the strict guidance of a qualified explosive handler. In addition, the following requirements apply to all lifting of explosives and units containing explosives:

- Operations involving lifting explosives with a crane or hoist shall be covered by a safety plan or shall be reviewed by the Hazards Control Department explosives safety engineer, who assists in determining whether critical lift requirements apply.
- The use of mobile cranes to lift bare or partially cased explosives requires a safety plan. When available, a manual hoist shall be used for lifting bare explosives.
- Operations with large explosive charges are considered critical lifts. Additional information about large explosive charges can be found in Document 17.1, "Explosives," in the *ES&H Manual.*
- Each crane or hoist approved for lifting explosives shall have the words EXPLOSIVES APPROVED stenciled on the equipment in plain view. (Contact your Hazards Control Department explosives safety engineer for details.)
- Motor vehicles equipped with boom-type cranes for handling explosive items shall be equipped with a spark arrestor for the exhaust pipe and a fire extinguisher with a minimum rating of 2A / 10BC. In addition, such vehicles shall be inspected before each use to verify that:
  - The mechanical condition is proper.
  - Safety appliances are working properly.
  - The engine and underbody of the truck are reasonably clean and free of excess oil and grease.
  - There are no bare wires or fuel leaks.
  - The vehicle is performing according to the manufacturer's requirements.
- Maintenance, repair, or service of mobile cranes shall not be permitted in an explosives storage area, operations building, or firing table if explosives are present.
- All rigging accessories and below-the-hook lifting devices shall be of approved design and construction for the weight and configuration to be handled.

- Bare explosive billets, fragments, or assemblies with exposed explosives shall not be lifted using either cranes or hoists unless an adequate lifting fixture is provided. An MESN outlining the conditions of design, fabrication, testing, and use shall be prepared for the below-the-hook lifting devices. Safety controls for the lifting operation shall be included in facility-specific documents (e.g., assembly procedure, peer review, or safety procedure documents).
- Prior to use, cranes shall be inspected by crane operators for proper operation and control according to DOE-STD-1090-99 and the manufacturer's instructions.
- Explosives shall not be lifted to a height in excess of that required to accomplish the job.
- Explosives and explosives assemblies shall not be left unattended while suspended.
- Mobile cranes shall not be refueled within 30.5 m (100 ft.) of explosives.
- All cranes and hoists approved for lifting explosives shall be load tested according to the guidance in DOE-STD-1090-99. Load hooks shall be nondestructively tested following load testing.
- Rigging equipment (except straps) used with explosives shall be load tested and tagged every 4 years.

4.0 Responsibilities

All workers and organizations shall refer to Document 2.1, "Laboratory and ES&H Policies, General Worker Responsibilities, and Integrated Safety Management," in the *ES&H Manual* for a list of general responsibilities. The specific responsibilities of individuals and organizations who have key safety roles in LLNL crane, hoist, and rigging operations are listed below.

4.1 Responsible Individuals for Work

Responsible Individuals for work shall:

- Verify that workers under their supervision receive the required training and are qualified (including medical examination, as required) and licensed to operate cranes and hoists in their areas.

- Verify that training is provided to prospective crane and hoist operators by a qualified, designated instructor who is a licensed crane and hoist operator and a full-time LLNL employee.
- Evaluate incidental crane and hoist trainees using the Safety Checklist in Appendix B and submit the Qualification Request Form to the Hazards Control Department to obtain the operator's license.
- Ensure that intermediate crane and hoist trainees complete HS5700, "Intermediate Crane Safety," consisting of 4 hours of lecture and 4 hours of hands-on training.
- Ensure that Plant Engineering professional riggers are trained and qualified to operate equipment in accordance with applicable industry standards. Records of trained and qualified riggers shall be kept on file in the Plant Engineering Department.
- Inform the Health Services Department when a crane operator is to participate in a lifting operation having unusual physical requirements or high-hazard consequences.
- Ensure that contract personnel are qualified to operate lifting equipment in accordance with OSHA requirements.
- Ensure that appropriate operator certification documents are forwarded to the contract administrator.

4.2 Responsible Individuals for Equipment

Responsible Individuals for equipment shall:

- Inform the Plant Engineering Department of all cranes and hoists that require formal inspections according to DOE-STD-1090-99.
- Ensure that hoisting equipment is inspected according to DOE-STD-1090-99.
- Ensure that cranes and hoists that are not inspected monthly are placed in the idle status. This effort shall be coordinated with Maintenance and Operations Division.
- Maintain copies of all monthly and annual inspections and records of modifications and repairs to cranes and hoists. Copies of annual inspections shall be provided by the Maintenance and Operations Division. Records shall be maintained for the lifespan of the equipment.

Some organizations may have maintenance responsibility for their cranes or hoists under a contract with either an outside agency (e.g., the equipment manufacturer) or the Maintenance and Operations Division. Responsible Individuals in organizations that have maintenance responsibility shall schedule the required maintenance and inspections and maintain the required records.

4.3 Crane and Hoist Operators and Riggers

Crane and hoist operators and riggers shall:

- Operate hoisting equipment according to DOE-STD-1090-99 and the manufacturer's instructions.
- Rig and configure loads according to industry-accepted safe practices.
- Conduct a preoperational inspection prior to using the equipment.
- Select, inspect, and use rigging equipment as specified in DOE-STD-1090-99 and the manufacturer's instructions.
- Have a valid operator's license on their person while operating cranes or hoists.
- Participate in the medical certification program, as required.

4.4 Plant Engineering Maintenance and Operations Division

The Maintenance and Operations Division shall:

- Perform annual maintenance and inspection of all LLNL cranes and hoists that are not covered by a program with maintenance responsibility.
- Conduct periodic and special load tests of cranes and hoists.
- Maintain written records of inspections and tests, and provide copies of all inspections and test results to facility managers and FPOCs who have cranes and hoists.
- Inspect and load-test cranes and hoists following modification or extensive repairs in accordance with the guidance in DOE-STD-1090-99 [e.g., a replaced hook, load-bearing component (other than wire rope), or structural modification].
- Schedule a nondestructive test and inspection for crane and hoist components as required by DOE-STD-1090-99, including inspection, before use, of new replacement hooks and other hooks suspected of having been overloaded. The evaluation, inspection, and testing shall follow the guidance in DOE-STD-1090-99.

- Maintain all manuals for cranes and hoists in a central file for program reference.
- Ensure that professional rigging personnel are trained and qualified in accordance with industry standards and DOE-STD-1090-99.

4.5 Mechanical Engineering Department

The Mechanical Engineering Department shall:

- Prepare MESNs for custom, LLNL-constructed rigging and lifting fixtures.
- Perform inspections and load tests to establish the capacity of special rigging equipment and fixtures, and affix labels with the capacity to equipment used for making critical lifts.
- Perform tests to certify LLNL-fabricated personnel platforms, baskets, and rigging.

These requirements may also be carried out by an outside vendor or the Plant Engineering Department. The Plant Engineering Department is the sole onsite source for test weights and rigging. Some equipment requires the use of weights, rather than pull-type machines, to conduct load tests.

4.6 Hazards Control Department

The Hazards Control Department shall:

- Conduct the following courses
  - Course HS5690, "Incidental Crane Safety."
  - Course HS5700, "Intermediate Crane Safety."
- Issue licenses to incidental crane and hoist operators and intermediate crane operators.
- Periodically verify monthly test and inspection reports.
- Interpret crane and hoist safety rules and standards.

4.7 Health Services Department

The Health Services Department shall:

- Provide medical certification of workers who operate mobile or cab- or pulpit-operated cranes.

- Provide review of workers in operating having unusual physical requirements or high hazard consequences.

5.0 Training

OSHA regulations require that only trained and designated personnel operate cranes and hoists. The Hazards Control Department therefore offers the following courses:

- HS5690, "Incidental Crane Safety."
- HS5700, "Intermediate Crane Safety."

The Plant Engineering Department is responsible for training, qualifying, and designating professional riggers in accordance with OSHA regulations and DOE-STD-1090-99.

6.0 Work Smart Standards

29 CFR 1910, Subpart F, "Powered Platforms, Man Lifts, and Vehicle-Mounted Work Stations."

29 CFR 1910, Subpart I, "Personal Protective Equipment."

29 CFR 1910, Subpart N, "Materials Handling and Storage."

29 CFR 1926, Subpart H, "Materials Handling, Storage, Use, and Disposal."

29 CFR 1926, Subpart M, "Fall Protection."

29 CFR 1926, Subpart N, "Cranes, Derricks, Hoists, Elevators, and Conveyors."

DOE Standard 1090-99, "Hoisting and Rigging" (DOE-STD-1090-99).

NFPA 70, Article 610, "Cranes and Hoists."

Occupational Medicine Standard: Medical Evaluation of Employees, Lawrence Livermore National Laboratory, Livermore, CA (UCRL-AR-129189).

7.0 Resources for More Information

7.1 Contacts

For additional information regarding this document, contact the following:

- Hazards Control Department
  - — Safety, Education, and Training Section.
  - — Occupational Safety Section.

- Area ES&H Team.
- Nondestructive and Materials Evaluation Section of the Manufacturing and Materials Engineering Division.
- Maintenance and Operations Division at the Livermore site and at Site 300.
- Mechanical Engineering Department.

7.2 Applicable Lessons Learned

For lessons learned applicable to the topics in this document, refer to the following Internet address:

http://www.llnl.gov/llnl_only/es_and_h/lessons/lessons.shtml

7.3 Other Sources

American Society of Mechanical Engineers (ASME)/American National Standards Institute (ANSI) B30.2, "Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)."

ASME/ANSI B30.9, "Slings."

ASME/ANSI B30.10, "Hooks."

ASME/ANSI B30.11, "Monorails and Underhung Cranes."

ASME/ANSI B30.16, "Overhead Hoists (Underhung)."

ASME/ANSI B30.17, "Overhead and Gantry Cranes (Top Running Bridge, Single Girder, Underhung Hoist)."

ASME/ANSI B30.20, "Below-the-Hook Lifting Devices."

ASME/ANSI B30.21, "Manually Lever Operated Hoists."

CMAA Specification No. 70, *Specifications for Electric Overhead Traveling Cranes.*

CMAA Specification No. 74, *Specifications for Top-Running and Under-Running Single-Girder Electric Overhead Traveling Cranes Utilizing Under Running Trolley* .

Environmental Protection Department, *Waste Acceptance Criteria*, UCRL-MA-115877, Livermore, CA (latest edition).

Mechanical Engineering Department *Design Safety Standards*, Chapter 2.2, "Lifting Equipment."

Appendix A

Terms and Definitions

Conventional rigging (equipment)	Hardware or equipment used to safely attach a load to a lifting device. Conventional rigging is commercially available, over-the-counter equipment used in the manner for which it was designed.
Crane	A machine that is used for lifting and lowering a load vertically and moving it horizontally and that has a hoisting mechanism as an integral part.
Hoist	A device that applies a force for lifting or lowering.
Mechanical Engineering Safety Note (MESN)	A document prepared by Mechanical Engineering and signed by a Mechanical Engineering division leader to validate the design, fabrication, testing, inspection, and use at LLNL of specifically fabricated, below-the-hook lifting devices.
Rigger	A worker employed by Plant Engineering who is designated to make lifts exceeding the limits for which a licensed incidental crane and hoist operator or an intermediate crane operator is authorized.
Special rigging (equipment)	Nonconventional rigging, including any equipment that is built at LLNL or that is not commercially available.
Tag line	A line that is tied to a suspended load to guide and manipulate the load.

Additional definitions can be found in Chapter 1, "Terminology and Definitions," of DOE-STD-1090-99.

Appendix B

Qualification Request Form and Safety Checklist

The Qualification Request Form and the Safety Checklist in this appendix are both required for obtaining an incidental crane and hoist operator license. The purpose of the Safety Checklist is to assess new operators' knowledge of crane and hoist safety requirements and their ability to safely operate a crane or hoist and make incidental lifts. The Qualification Request Form establishes the need for new operators to operate a crane or hoist for their job assignment and verifies completion of the necessary training (i.e., course HS5690).

A licensed operator who is qualified to operate the type of equipment for which the new operator is being evaluated shall complete the Safety Checklist by initialing each item in the space provided to indicate that the new operator has demonstrated knowledge in the particular area or by writing "NA" for items that do not apply. Both the licensed operator and new operator's supervisor shall sign the completed checklist.

The new operator's supervisor shall then complete the Qualification Request Form and forward it with the Safety Checklist to the Hazards Control Department for approval. Upon approval by the Hazards Control Department, the operator is issued a license. The operator shall have this license on his or her person when operating cranes or hoists.

Qualification Request Form for Incidental Crane and Hoist Operator License

Operator's name: _____ Employee No: _____
(or Contract No.)

Job Title _____

Dept./Div.: _____ Ext. _____ L Code: _____

SUPERVISORS: By completing and signing this form, you are certifying that the operator

1. Is required to operate a crane or hoist as part of his/her job assignment.
2. Has completed course HS5690 (Incidental Crane Safety) on _____.
   Date
3. Has had on-the-job training for a period of months operating a crane or hoist under supervision.

Note: The training period must be no more than 6 months upon completing course HS5690 or the operator will have to repeat the course.

4. Has been evaluated using the Safety Checklist in this appendix and is capable of operating a crane or hoist and making incidental lifts safely.

Supervisor: _____ _____
(Print name) (Signature)

L-Code: _____ Date: _____

Forward the completed form to the Hazards Control Department, L-386, for approval. Make sure the checklist is attached.

Hazards Control Department Approval

_____ Date: _____

Safety Checklist for Crane and Hoist Operation

A licensed operator who is certified to operate the type of equipment for which the new operator is being evaluated shall complete this checklist by initialing each item in the space provided to indicate that the new operator has demonstrated knowledge in the particular area or by marking "NA" for items that do not apply. Both the licensed operator and new operator's supervisor shall sign the completed checklist.

Operator's Name: _____
(Please print)

_____1. Describe the difference between a bridge crane and a hoist. (A bridge crane operates on two tracks; a hoist operates on a single monorail track.)

_____2. Why is a bridge crane more versatile than a hoist? (The bridge crane has 4-way horizontal movement, while a hoist has only 2-way horizontal movement.)

_____3. What are the components of a bridge crane? (Bridge, trolley, hoist drum, hoist cables, hoist block and hook, pendant, stops, bumpers, and limit switches.)

_____4. What are the standard markings used on a bridge crane control pendant? (Raise, lower, trolley east, trolley west, bridge north, bridge south, on / off switch.)

_____5. Why are on / off switches required on control pendants? (For emergency stops in the event that any of the pendant controls fails.)

_____6. If a crane's bridge, trolley, and hoist have more than one speed, describe the proper lifting procedures. (Start with the slowest speed and progressively increase to the highest.)

_____7. Explain the term "drum overlapping," as it pertains to a bridge crane, and the primary cause of overlapping. (The hoist cables will not lie properly in the grooves on the hoist drum if the operator does not center the hook over the load and start lifting the load from an angle.)

_____8. When should a bridge crane be checked for drum overlapping? (Prior to each use.)

_____9. How many wraps of wire must still be on the hoist drum when the hoist hook reaches the lowest working level in the work area? (No less than two full wraps of wire must be left on the hoist drum.)

_____10. Which hoists are required to have upper-limit switches, and how often should these switches be tested? (All motor-driven bridge cranes and hoists are required to have upper-limit switches, and they must be tested each day the crane is used.)

_____11. When are lower-limit switches required? (In any area that has lower working levels [e.g., pits]. Hoists that do not have enough wire on the drum to lower the hook to the lowest level and maintain at least two full wraps of wire on the drum must be fitted with lower-limit switches.)

_____12. Should limit switches be depended upon to stop the hoist movement? (Never. Limit switches are installed for safety only, and no operator should depend upon them for normal stopping.)

_____13. Where is the main electric disconnect for the bridge crane or hoist located? (Normally, a separate disconnect switch is located in a wall-mounted box with lockout capability.)

_____14. What are the proper procedures for cranes found to be defective (e.g., the upper-limit switch does not operate, a pendant control fails, the hoist does not hold the load)? (Report the defect to the supervisor immediately, lock out and tag the crane's main electrical disconnect switch, report the defect to Plant Engineering Maintenance and Operations Division [PEM / OD].)

_____15. Are movement alarms required on pendant-operated bridge cranes? (Alarms are not required; however, if a crane is fitted with a movement alarm, it must be maintained in working condition.)

_____16. Is a written, signed inspection report required for all bridge cranes and hoists, and who should complete that report? (The inspection is completed monthly by a responsible individual assigned by the supervisor and documented on the Monthly Inspection Report Form [LL-5204].)

_____17. Explain the action required if there is a hoist brake drift when the hoist stops with a load suspended. (There should be no hoist drift; if there is, the brake is not holding and should be reported to PEM/OD.)

_____18. Why is the hook always centered over the load? (To prevent drum overlapping and stress on the hoist and lifting fixtures.)

_____19. At what height should a load be lifted when it is being moved. (Only lift a load high enough to clear all obstructions in its path. Never move a load over personnel or costly equipment.)

_____20. When it is permissible to leave a load suspended on a crane hook, and who should be notified if mechanical problems prevent landing the load? (It is never permissible to leave a load suspended. The load must be landed and the slings removed from the hook. If there are mechanical problems, the PEM/OD shall be notified.)

_____21. Describe the procedures for parking a crane. (Remove all accessories from the hook, raise the hook 2.1 m (7 ft) above the floor level, store the pendant clear off work areas or aisles or 2.1 m above the floor level if the crane is fitted with a pendant-retracting reel, and place the stop switch in the OFF position.)

_____22. Can a person work under a suspended load? (Never, unless the load is supported by blocks or jacks.)

_____23. Can operators exceed the maximum capacity of a crane or hoist? (An operator shall never exceed the maximum capacity marked on both sides of the bridge or monorail for a hoist.)

_____24. What is the minimum safety factor for slings? (The safety factor for slings is 5 to 1.)

_____25. What precautions should be taken when using wire-rope slings or synthetic-webbing slings? (Protect the slings from sharp edges by using padding. This is especially important when using synthetic-webbing slings.)

_____26. Explain the proper procedure to follow if a synthetic sling is too short. (Use a shackle to join the two slings together. Never tie a knot in a sling, as this will weaken it considerably.)

_____27. What precautions should be taken when using eye bolts as lifting fixtures? (Ordinary eye bolts should only be used for straight pulls and must have a minimum of 1-1/2 times the bolt diameter threaded into the load. Shoulder-type eye bolts must have the shoulder tightly secured against a flat surface. The safe working load of an eye bolt decreases rapidly as the angle of the pull increases. Safety hoist or swivel rings are preferred and recommended.)

_____28. Describe the proper installation procedures for wire-rope clips. (The saddle of the clip must always rest on the part of the wire that will hold the load and take the stress. The U-bolt part of the clip must rest against the dead-end of the rope. The nuts must be tightened with a torque wrench to the clip manufacturer's settings.)

_____29. What effect will a kink in a wire rope cause? (A kink weakens the wire considerably. Any wire rope with a kink must be cut up and discarded to prevent reuse.)

_____30. What must an incidental crane and hoist operator do if a load weighs more than 225 kg (500 lb)? (Get his/her supervisor's approval prior to making the lift.)

Licensed Crane and Hoist Operator: _____
(Signature)

Supervisor: _____
(Signature)

Submit this checklist and the Qualification Request Form for an Incident Crane and Hoist Operator license to the Hazards Control Department (L-386) for approval.

Appendix C

Hand Signals

Individuals responsible for directing crane and hoist operators during lifting operations shall use standard hand signals (see Fig. C-1) or other signals as discussed in Section 3.8. These signals shall be conspicuously displayed in work areas to ensure proper use.

Hoist	With forearm vertical and forefinger pointing up, move hand in a small horizontal circle.
Lower	With forearm extended downward and forefinger pointing down, move hand in a small horizontal circle.
Stop	With forearm extended to the side and palm down, hold position rigidly.
Emergency stop	With arm extended to the side and palm down, move hand rapidly right and left.
Bridge travel	With forearm extended forward, and hand open and slightly raised, make pushing motion in the direction of travel.
Trolley travel	With palm up, fingers closed, and thumb pointing in the direction of motion, jerk hand horizontally.
Move slowly	Use one hand to give any motion signal, and place the other hand motionless in front of the hand giving the motion signal.
Multiple trolley cranes	Cranes that are equipped with two separately operated trolleys present the problem of establishing signal person to operator signals when both trolleys are being operated to accomplish the work at hand. Thus, crane trolleys should be numbered with numerals large enough to be legible from the floor. For example: • The trolley nearest the crane cab should be No. 1. • The trolley away from the crane cab should be No. 2. • Where cabs are located in the center of crane girders, the trolleys and load blocks should be numbered. Hoist load blocks should have numbers applied on both sides of the block. Use a one-finger sign for the No. 1 trolley and a two-finger sign for the No. 2 trolley, followed by the standard hand signals.
Connecting and disconnecting magnet leads	When magnet leads are to be connected or disconnected, or when magnet repairs are to be made, the crane operator should open the magnet switch at the request of the signal person on the ground, who should wait for the safe sign from the crane operator that the magnet switch is open. (The safe sign is given by the operator spreading both hands apart, with the palms up.)

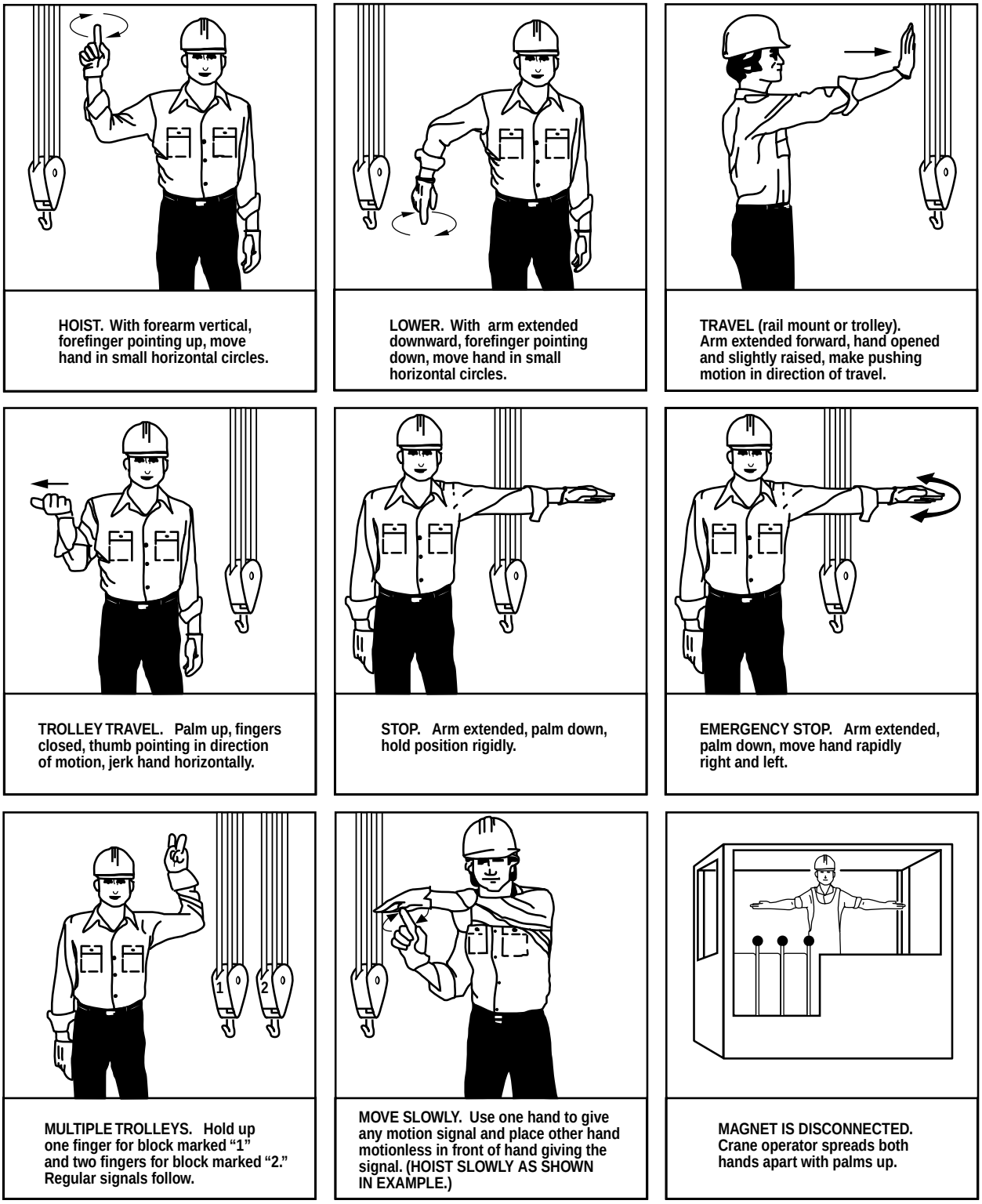

Figure C-1. Standard hand signals.

Appendix D

Inspection, Maintenance, and Test Schedule for LLNL-Operated Cranes, Hoists, and Rigging Equipment

The activities specified in this appendix are to be performed as indicated. Deviations from these requirements shall be approved by the appropriate levels of management.

Table D-1. Inspection, maintenance, and test schedule for LLNL cranes and hoists.

ACTIVITY to be performed	WHEN	BY	THEN complete
Inspection			
Cranes, hoists, and rigging Equipment	Monthly	Responsible facility	Form LLNL-5204. Additional information on these devices can be found in this document.
Mechanical, electrical, and Safety devices	Annually	Plant Engineering	Plant Engineering Planned Maintenance Work Request. Additional information on these devices can be found in the ANSI B30 standards and DOE-STD-1090-99, "Hoisting and Rigging."
Mobile cranes	Annually	Certified inspectors	Certificate of test and inspection. Additional information on mobile cranes can be found in DOE-STD-1090-99.
Preventative Maintenance			
Lubrication of wire rope and all moving parts	Annually or periodically, as necessary	Plant Engineering	Plant Engineering Planned Maintenance Work Request.
Adjustments and repairs	Annually or periodically, as necessary	Plant Engineering	Additional information on these devices can be found in the ANSI B30 standards andDOE-STD-1090-99.

Appendix E

Sample Hostile Environmental Plan

The purpose of this document is to formally identify equipment used in hostile environments that require alternative methods of inspection or testing, and to establish the criteria that will be used to ensure safe operation and worker safety.

In addition to this document, the requirements of Document 2.3, "LLNL Exemption Process," in the *ES&H Manual* shall be met.

Building: _____ Location: _____

List the type of crane / hoist (e.g., overhead top-running bridge and trolley; top-running bridge with underhung hoist; jib crane; monorail hoist; and overhead hoist).

_____

Manufacturer: _____

Capacity (main and auxiliary):_____ Power method:_____

1. List the crane / hoist safety requirements (see Document 15.3, "Crane, Hoist, and Rigging Safety," in the *ES&H Manual*) that will not be met.

_____

_____

2. List the difference between the requirements and those allowed by this plan.

_____

_____

3. List any justification for not meeting the requirements.

_____

_____

4. List any actions or features to compensate for the differences.

_____

_____

5. Include information regarding replacement or retirement criteria for this equipment and any special design, maintenance, or test considerations that apply to the equipment.

_____

_____

CONCURRENCE

Facility Manager: _____ Date: _____

Responsible Individual (if applicable): _____ Date: _____

ES&H Team: _____ Date: _____

PE/MOD (if applicable _____ Date: _____

APPROVAL

Authorizing Individual: _____ Date: _____